Wet(ter)

A Landscape Strategy for a Coastal Island in the Bengal Delta

Anta Sharif Chowdhury

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Contents

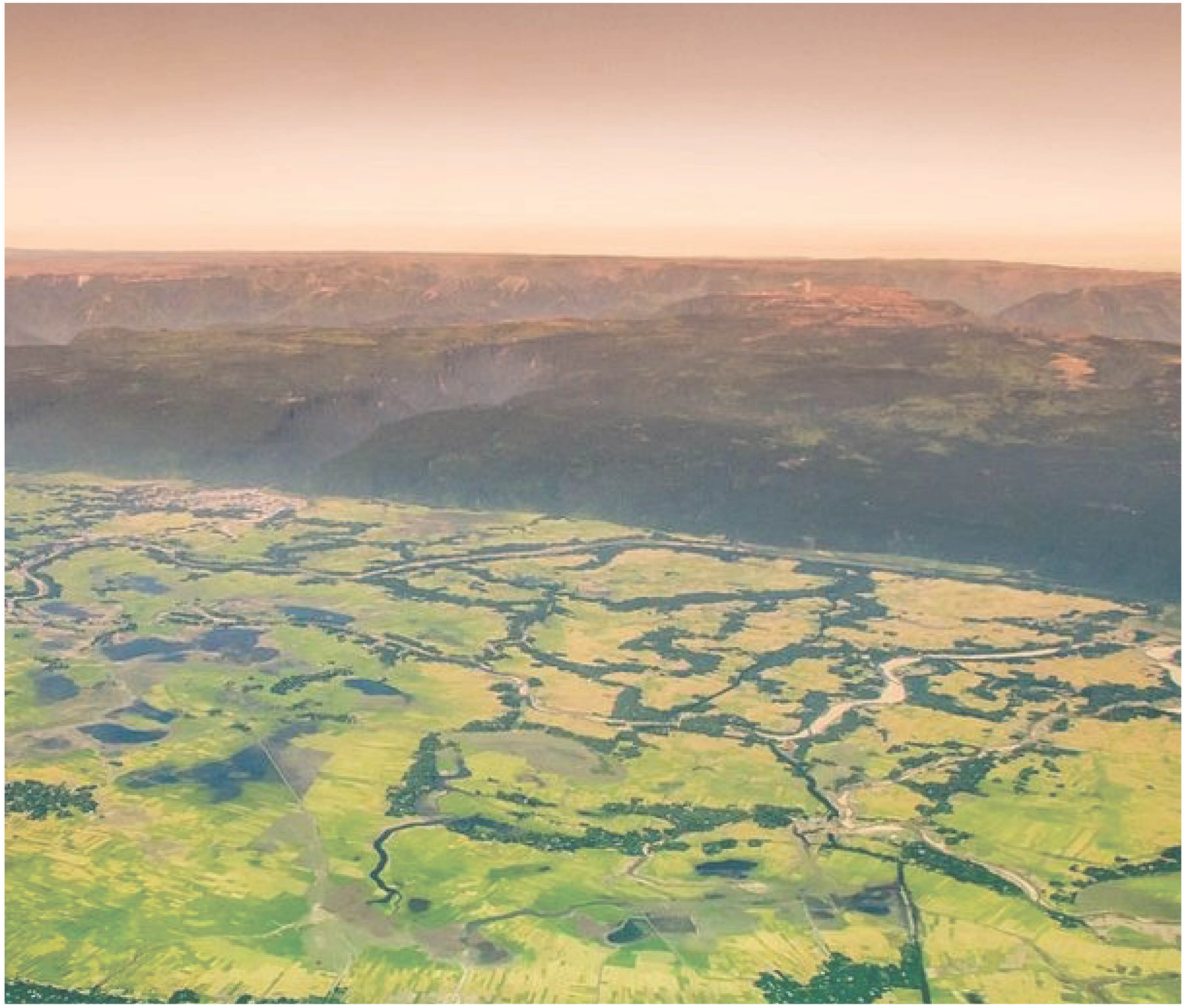
A Wet Terrain

Imagining a wet(ter) future, this project explores how landscape strategies can generate adaptive and dynamic livable spaces in the Bengal Delta coastline.

The coastal area will gradually loose much of its land under the sea, forming a series of new islands due to sea-level rise. Millions of climate change refugees have begun to migrate to higher land, however it has been predicted that by the year 2100 approximately 5 million people will continue to live in the coastal delta.

How can the local traditions be adapted so people can inhabit the future landscape of the delta?

Finding itself placed upon an island in the delta, the project investigates the interplay between protective-productive landscapes, transportation infrastructure and urbanity.



Photograph: Shamin Shorif Susom, Feni, Bangladesh

A Shifting Landscape built by Water

This thesis is about the shifting landscapes of Bangladesh delta, a landscape built by water.

Water constructed its landscapes through centuries of sediment transportation from the Himalayas, making it a tide-dominated delta.

Water constructed its cultural landscapes by nourishing its soil with rich silts.

Here, water created life and became a source of living.

Then, water became the connector for the landscapes and the livings by flowing literally everywhere.. in every corner, as if reaching almost every home.

It created cities.. the capital city dates back to 400 years back originating by the river Buri-Ganga and all the major cities became significant connection points through river or sea ports.

This is the shifting landscape of Bangladesh, where water builds, but it is also a threat.

It is a contemporary uncertain landscape, a tide dominated delta, where historically the landscapes produced conditions for widely distributed inhabitation.

Photograph: Shamin Shorif Susom, Bangladesh

The Bengal Delta

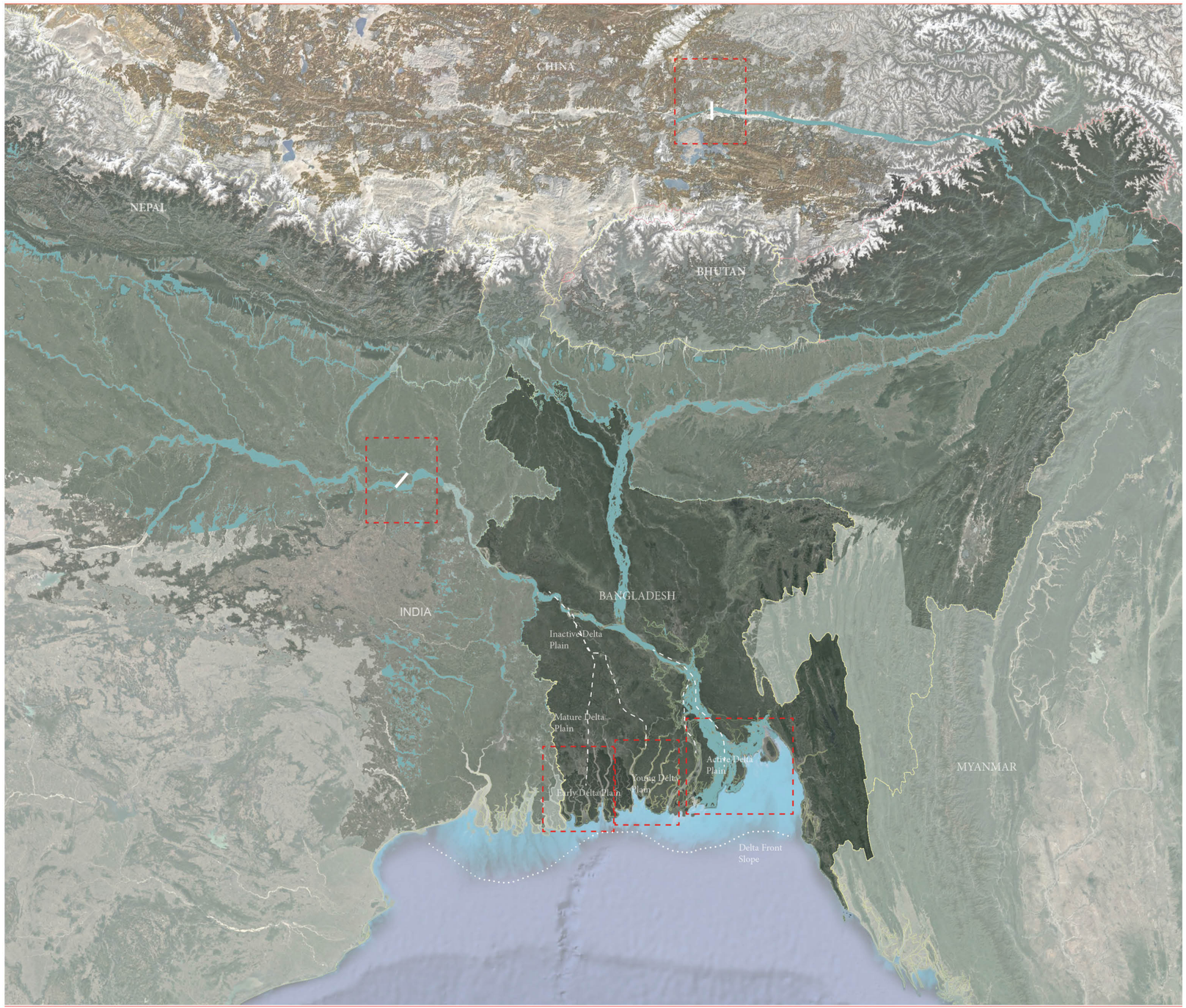
It lies at the foothills of Himalayas in between India and Myanmar. It's located in the basin of 3 major rivers- Ganges, Brahmaputra and Meghna. Ganges and Brahmaputra are originated from the west and north of himalaya respectively, bringing in almost 1 billion tons of sediments annually. These two rivers move southward meeting Meghna and finally emptied in bay of Bengal.

The two main upstream large infrastructures lie in India and China as Farakka dam and ZangMu dam.

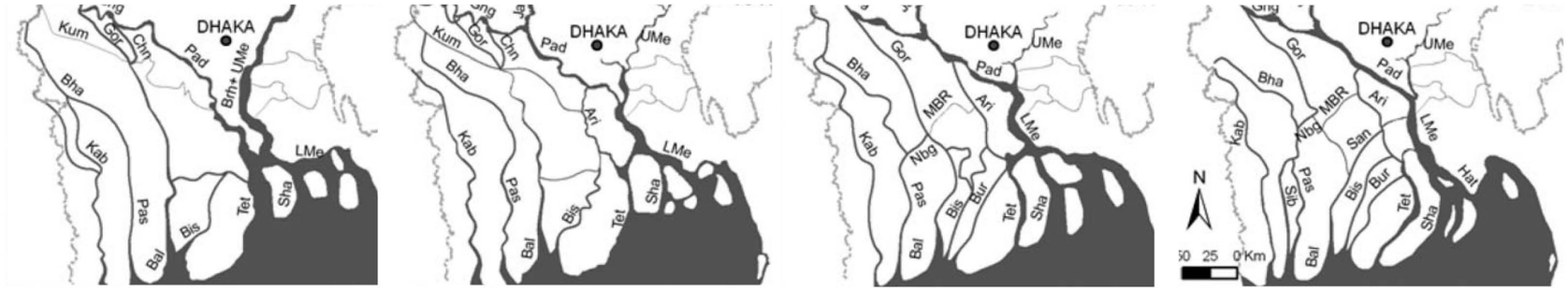
These sediments have created the delta for over 6000 years but natural phenomenas for example, a recent earthquake in Assam in 1950 has accelerated the process.

The rivers changed their course over time, creating at first the matured plain, then young plain and the current course is building the active delta and forming new lands.
The highly dynamic nature of this tide dominated delta in due to interaction between 2 strong opposing agents of delta building activities - fluvial and marine processes, having delta front of 20-100kms that reserves the sediments and potential of future land building, and the delta front slope.

The extremely fertile landscapes and abundance of fresh water supply made it a productive and densely populated region. In return creating need for more cultivated lands and dense cities, meaning loss of forests. For a land where 80% lies in a flood plain, 1/4th under 2m elevation, having a forest coverage of 11% is rather alarming.



Deltaic Basin
Brahmaputra, Ganges and Meghna Basins



1776 1840 1943 2010

From James Rennel map in 1776 to today's documentations, significant change in the active delta has been observed.
The land formation in the active delta during this time of 240 years is over 1000 km2.

Sea Level Rise

Today the reports of climate change reveal itself to threaten the future of the parts of this territory.

These bring the necessity for understanding-

How these landscapes can change again- creating resilient landscapes by exploring the limits of landscape strategy to transform them?

What can be the role of landscape strategies in a context of Sea level rise?

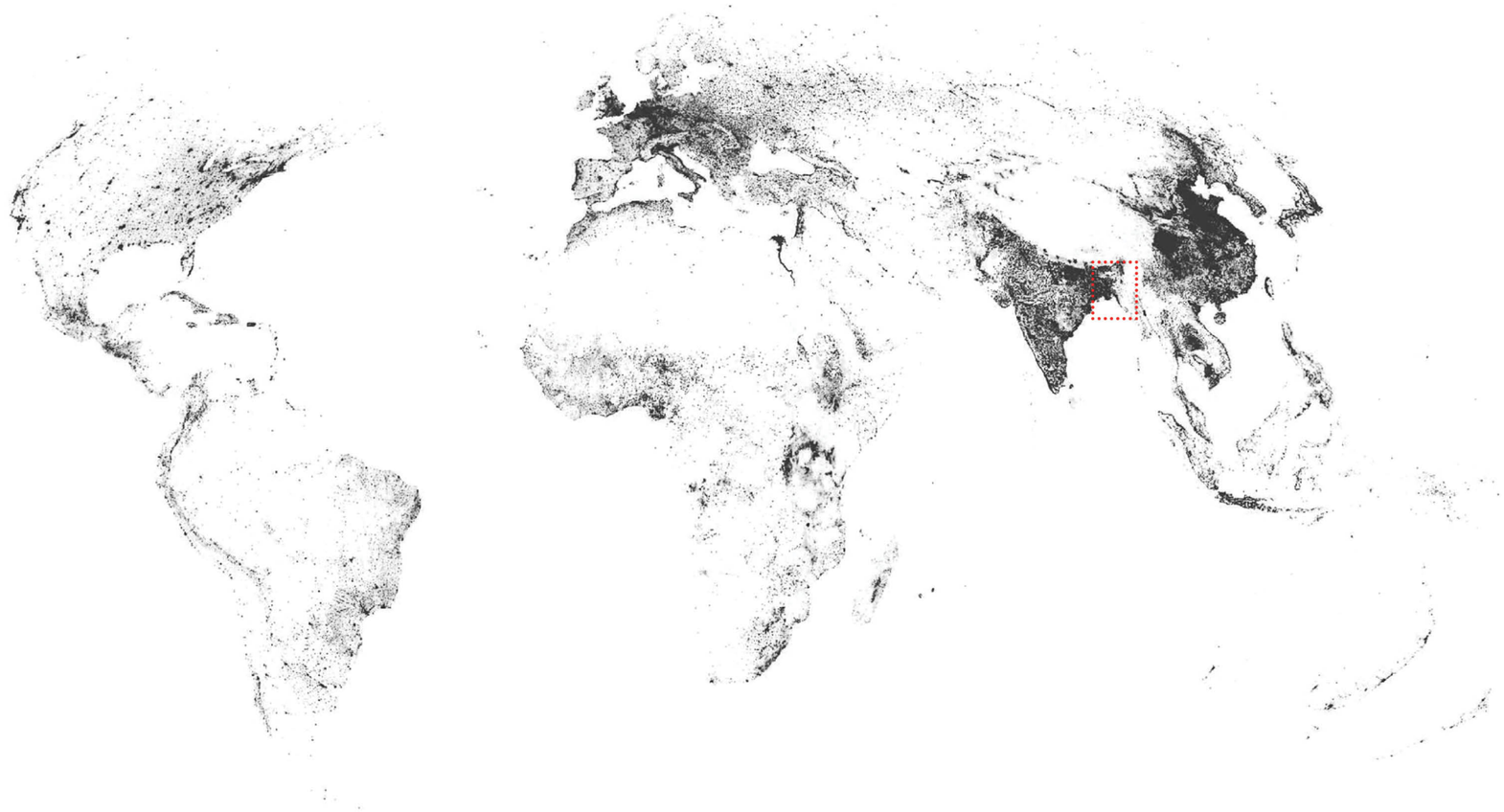
The regions most vulnerable to sea level change are also the most densely populated regions. Bangladesh being one of the most vulnerable places, with a population of 0.16 billion, 2.1% of the world population within an area of half the size of Norway.

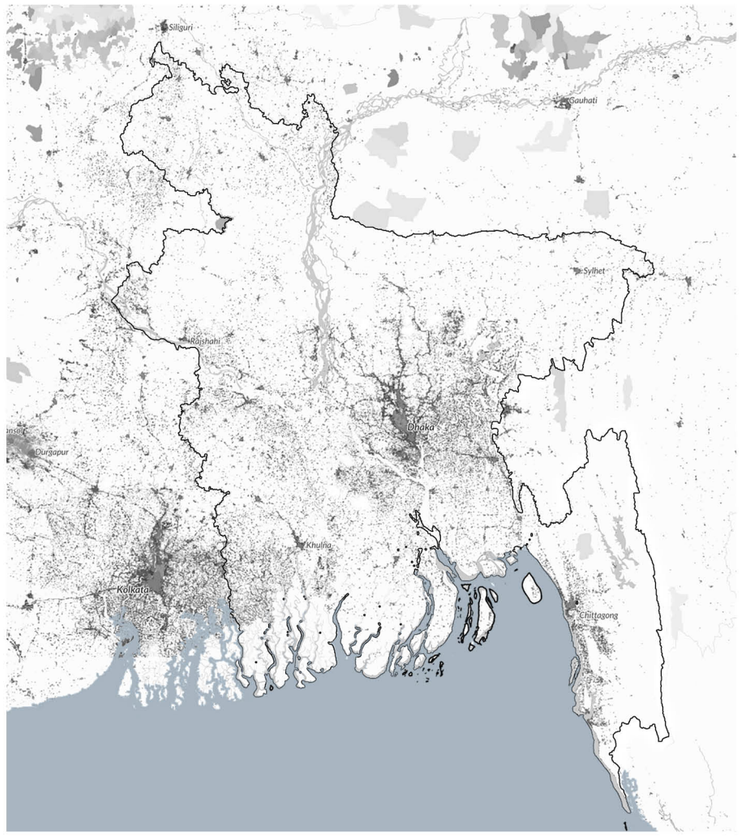
At a +1m sea level rise, almost 15 million people and 17000 km2 land area is estimated to be affected by 2100.

Photograph: Shamin Shorif Susom, Rangamati, Bangladesh

billion people 7.6, in research area 0.16 | 2.1%

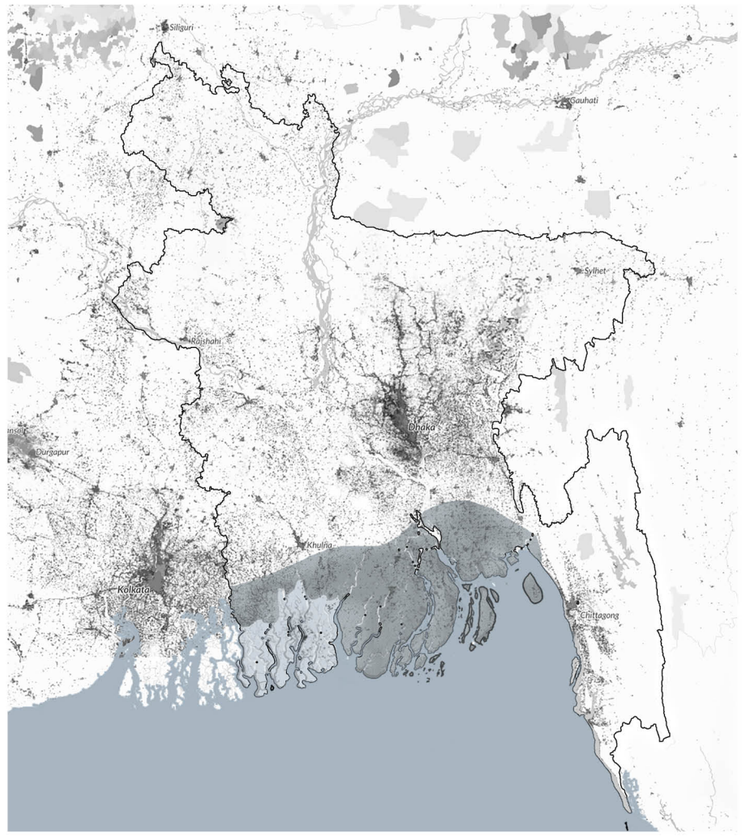
World Population Density
Source: European Commision, Joint Research Center, 2015





Present sea level

Information Source: Dhaka University Intergovernmental Panel on Climate change



+1m Sea Level Rise

15 million people affected **9.3%,** 17000 km2 of land affected **11.5%**

Migration

Where will they go?
80% of the country is rural. Rural areas are mostly agricultural lands cultivated by local farmers, not many work possibilities for the displaced people.

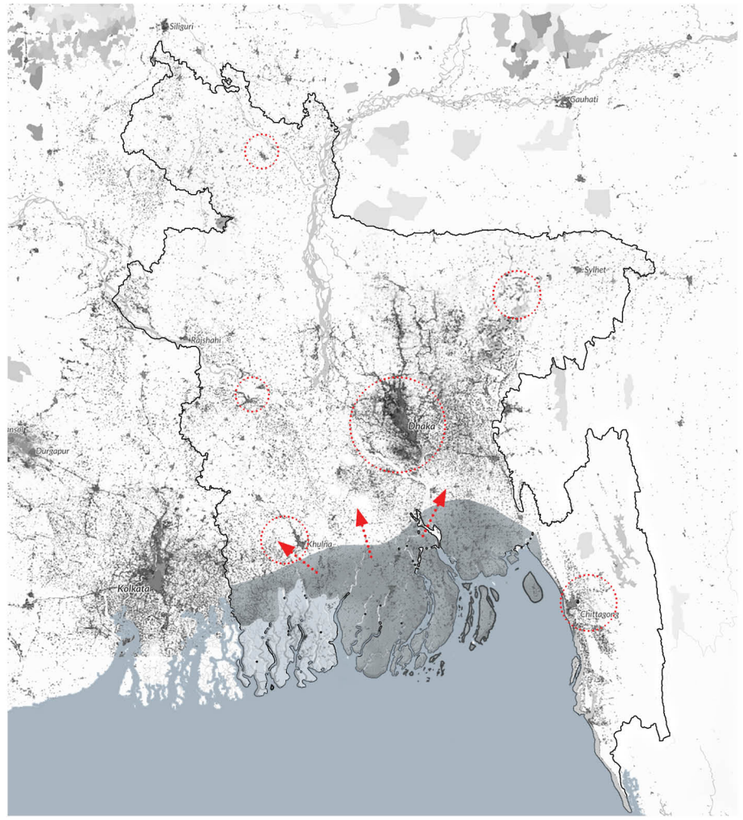
So they will move to cities.
Human migration due to environmental reasons are already occurring, 500 people move toward cities everyday in search of a job. This creates a more polarized urban system, creating more slums with poor living conditions, increased urban flooding. But most significantly, pressure on groundwater which is the 90% source of water supply. The long term effect of this is sinking of earth and more vulnerability to salt intrusion.
Large scale Migration in a rapid pace, in return poses new environmental and economical threats.

Impacts of Migration
at Present

Economical:
Pressure on the dense urban areas
Unhealthy work environments

Social:
Creation of more slums
2.23 million slum dwellers 1.4%
Poor living conditions

Environmental:
Increased Urban flooding
Pressure on water supply in the cities
Decline of ground water in the urban areas 90% of water supply is from ground water
Long term decline results in earth sink
and Salinity intrusion



BY 2100

10 million people 9.3%

At present:
0.73 million people migrate annually

towards the city 0.45%

25% for environmental reason:
Loss of Agricultural Land
Salinity intrusion
Lack of fresh water
Tidal surge
Water logging

Pokhalde Glacier, Himalayas
1956 | 2007

1956 picture taken by Erwin Schneider, courtesy of the Association for Comparative Alpine Research, Munich. 2007 image photographed by Alton Byers of the Mountain Institute

The sea level is rising, glaciers are melting, but it also means that there are more flows in the rivers and they carry more sediments.
So what can be the probable future?

Probable future

One probability is: with regional cooperation with neighboring countries, partial control over the upstream flows of river, moderate climate change, technological advancement in eco- agriculture, political intention of investment in river and water resource management, the coastal lands continue to get fresh water supply and form lands.

Most of the people in coastal areas continue to live in that area with diversified economic activities, while making interventions upstreams to control flooding and erosion.

Another probability is- where regional cooperation is limited, no control over upstream flows, moderate climate change, political intention to invest in large forestation project, technological advancement in eco- agriculture.

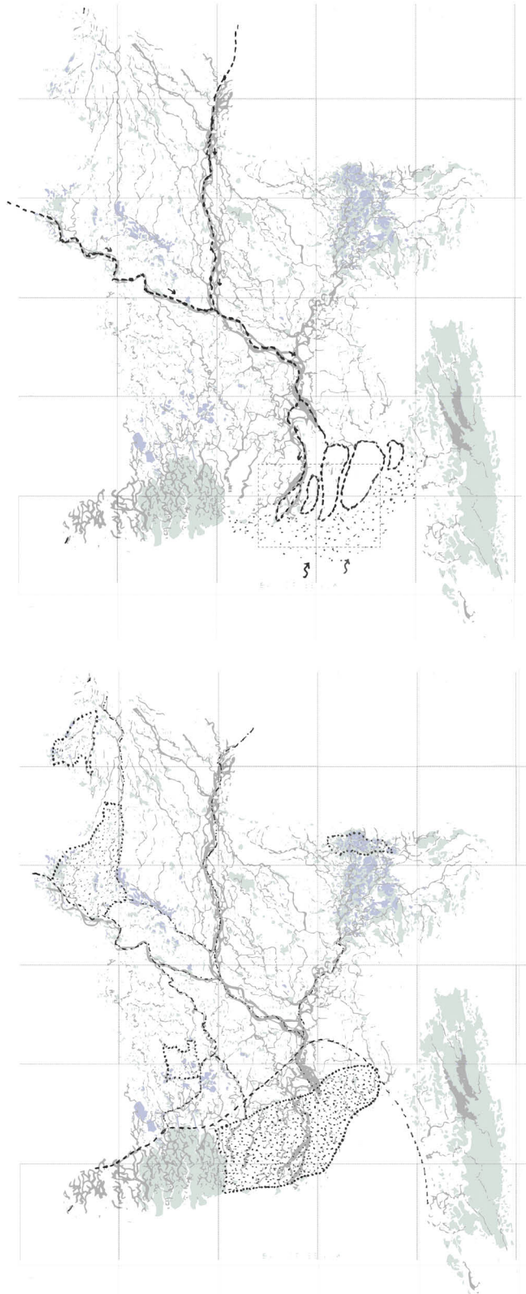
The coastal lands are lost to salt intrusion and sea water. People migrate from the coastal areas to safer high grounds.

Year 2100

The current trends of migration indicate a social resilience among the people living in the coastal areas, they tend to adapt and re-establish their life after a natural disaster strikes.

The migration statistics suggest that there will still be approximately 5 million people living in the affected area in 2100.

With the significant changes in landscape and impacts of sea level rise, how can these people continue to live there safely and make a sustainable living?



Good Regional co-operation

Regional co-operation with neighbouring countries, India and China
Partial control over the upstream river flows
Open/ Controlled Dam upstreams, outside international borders
Seasonally opened dams: Zangmu Dam in Tibet, Farakka Dam in India
Moderate climate change
Technological advancement in eco-agriculture
Political intention to invest in river and water resource management.

Limited Regional co-operation

Limited regional co-operation with neighbouring countries, India and China
Moderate climate change
Technological advancement in eco-agriculture
Political intention to invest in large scale forestation project.

New Morphologies: Islands

The low elevation affected coastal area will have gradually lost much of its land under the sea, the rest will be affected by salt intrusion and erosion.

Much of the remaining lands will be in form of islands.

How can the local communities adapt to these new morphologies of land, using the traditional ways of living and commuting?

Photograph: Shamin Shorif Susom, South Coast, Bangladesh

Coastal zone

What lies in this coastal zone?

Habitat of more than 750 fauna species and more than 1000 flora species. It consists of 50% forest of the total in the country, including mangrove forests.

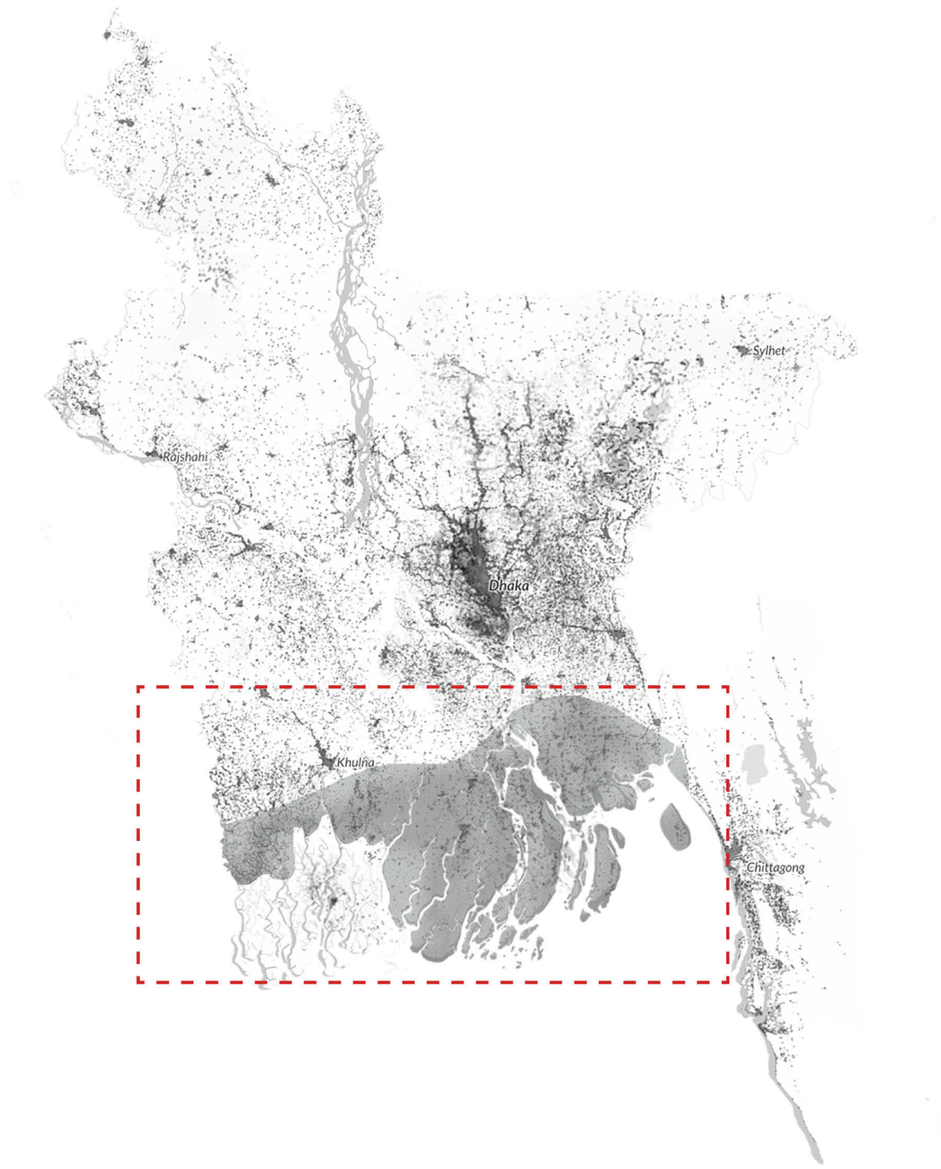
17 thousand km2 coastal plain
19 out of 64 administrative units
11.5% of total land area
9.3% of total population

Impacts of Sea level rise

Economical:
Loss of agricultural land
(At present Bangladesh is self-sufficient in food grains, food security will be threatened)

Social :
Human Migration of 9.3%

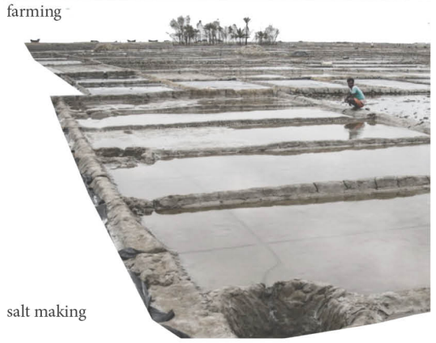
Environmental:
Loss of habitat of species
Royal Bengals may decline upto 96%
More flooding in inlands
Exposure to salinity
More vulnerable to natural disasters



Land uses:
Farming, forestry, salt making, ship breaking, ports, shrimp farming and other types of aquacultures.


farming


ship- breaking


salt making


fish drying


fishing


cattle


aquaculture


port

Land use types

Habitat of species

One Island: Char Kajal

This project focuses on one particular island, named Char Kajal as a research area.

In the coming decades, this island will still be inhabited, but by fewer people. It is an empoldered island with 21000 inhabitants. 80% of the land is currently cultivated which will be affected by sea level rise.

It is a coastal island, but it can be safer to live than the first line of islands. It is already connected with the mainland through river and thus boats can be a possible future for connectivity among the new islands. The strategic principles can be applied in similar islands.

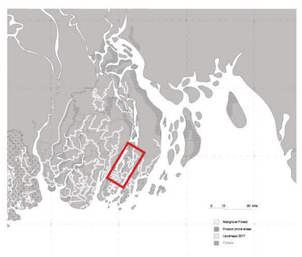
Most of the lands are cultivated and water networks are disconnected from main river stream of Tetulia. Consists of inhabited forest and earth roads with some bazar and ports as exchange hubs.

Future Morphologies: South Coast, Bangladesh

Char Kajal is 22 x 7 km in area,
slightly larger than the manhattan island.

1984-1998 1998-2017 1984-2017

It lies in the active delta and its form is shifting even today.



Char Kajal, South Coast, Bangladesh

Inhabited Forest

Traditional houses
within lush vegetation

Road network:

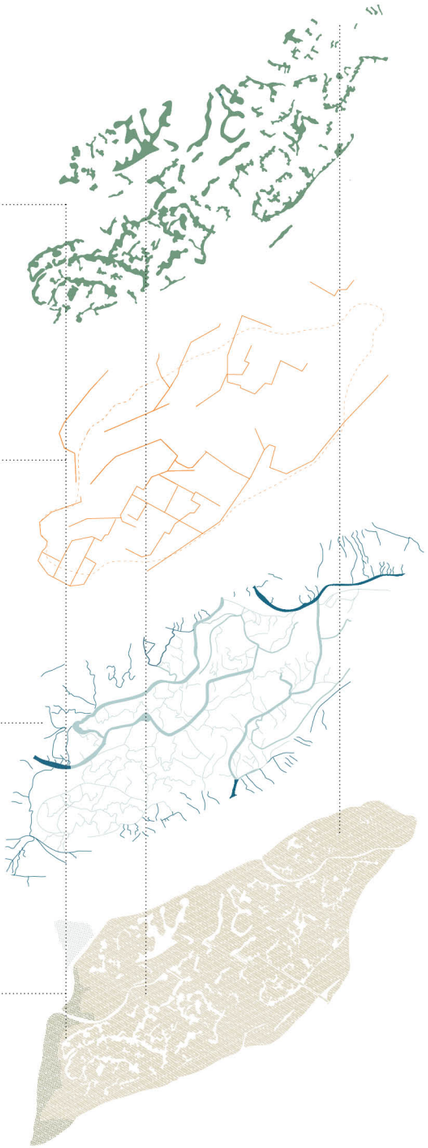
Higher than fields
Made of earth
Works as dike on the river

Water network:

Internal and external net-
works separated by polder
Disconnected by roads in
some parts

Cultivated and forest:

Mangrove forest in south coast
80% cultivated land



Most of the lands are cultivated and water networks are disconnected from main river stream of Tetulia. Consists of inhabited forest and earth roads with some bazar and ports as exchange hubs.

Char Kajal, South Coast, Bangladesh

Challenges of the area

Reduced agricultural productivity
(Due to flooding and salt intrusion)
Mobility/ Transportation
Decreased fresh water supply
Water logging/ flood
More vulnerable to cyclones

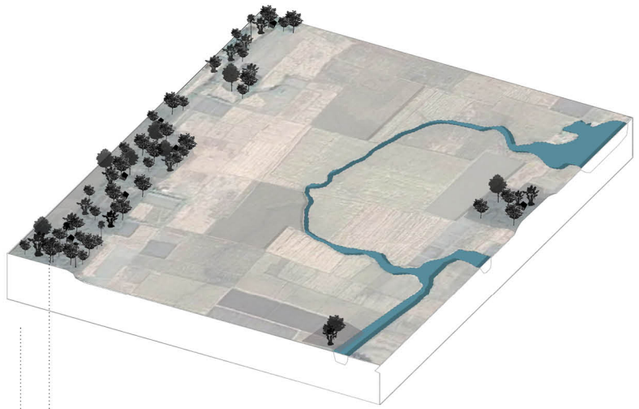
Opportunities

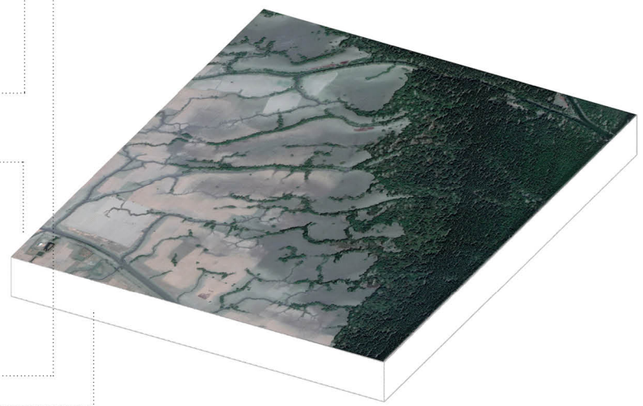
Aqueous Terrain:
Low and Highlands
Natural water networks
Rain water collection
Wetlands
Waterway transportation
Dynamic landscapes
Seasonality

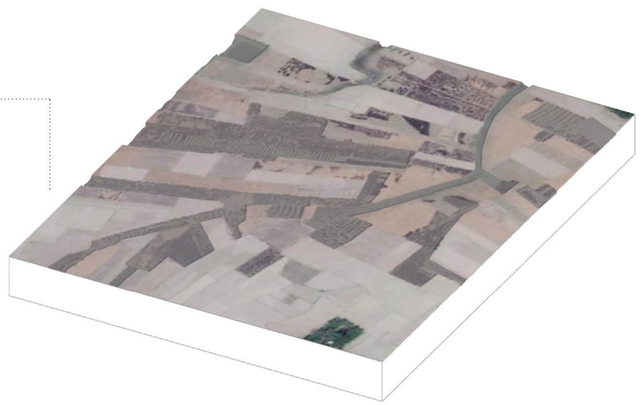
Inhabited forests:
Suitable for Mangrove species
Salt water forest
Productive forests

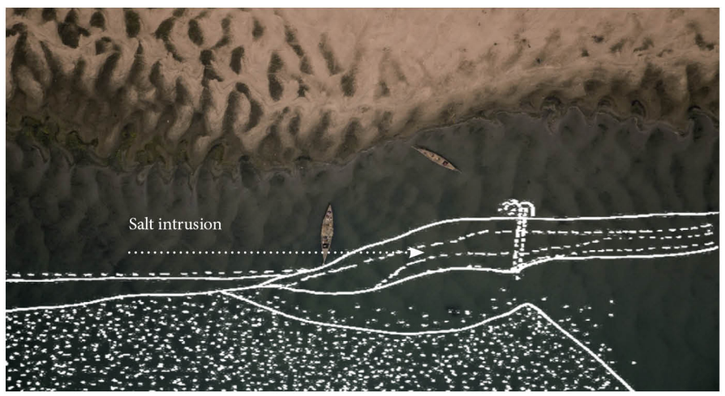
Diversed productive landscapes:
Aquaponis
Salt water aquaculture
Economic corridor

How can we intergrate these dynamic water landscapes with public spaces, forests and traditional agriculture to create a diverse productive landscape, that will ensure the economic sustainability and safety from natural hazards?









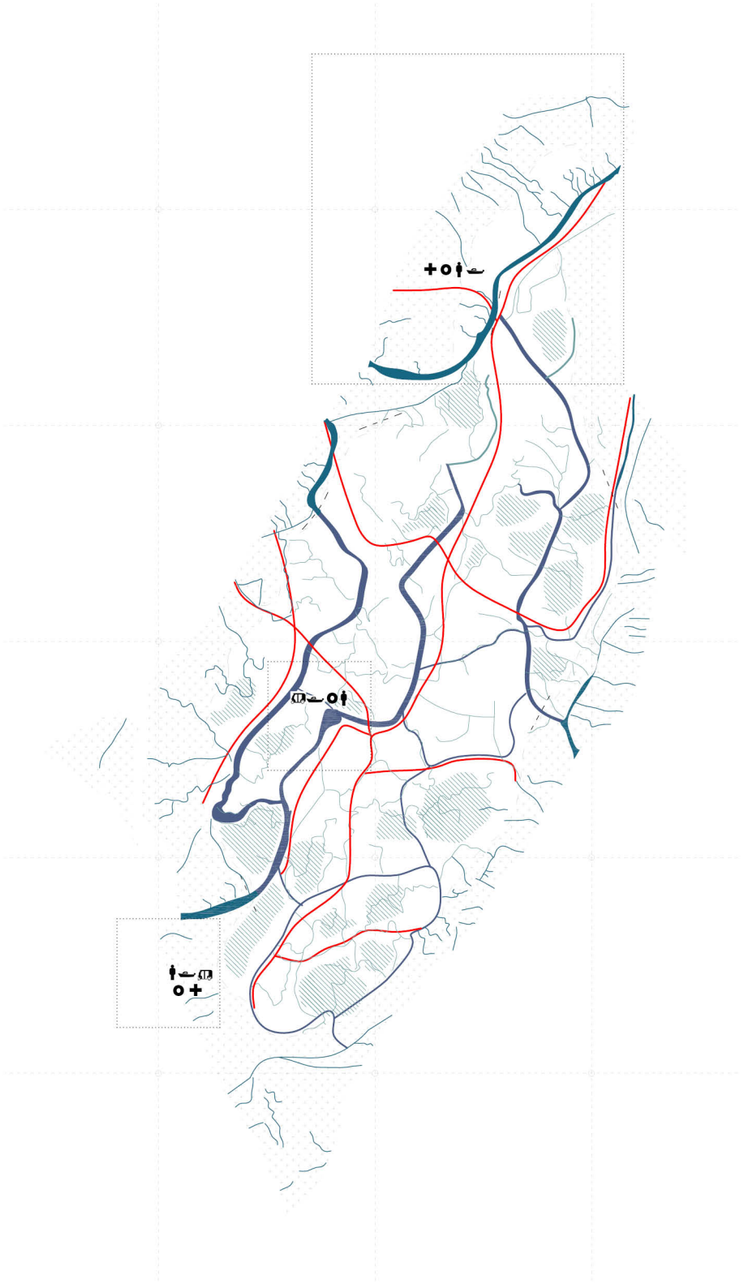
Strategy

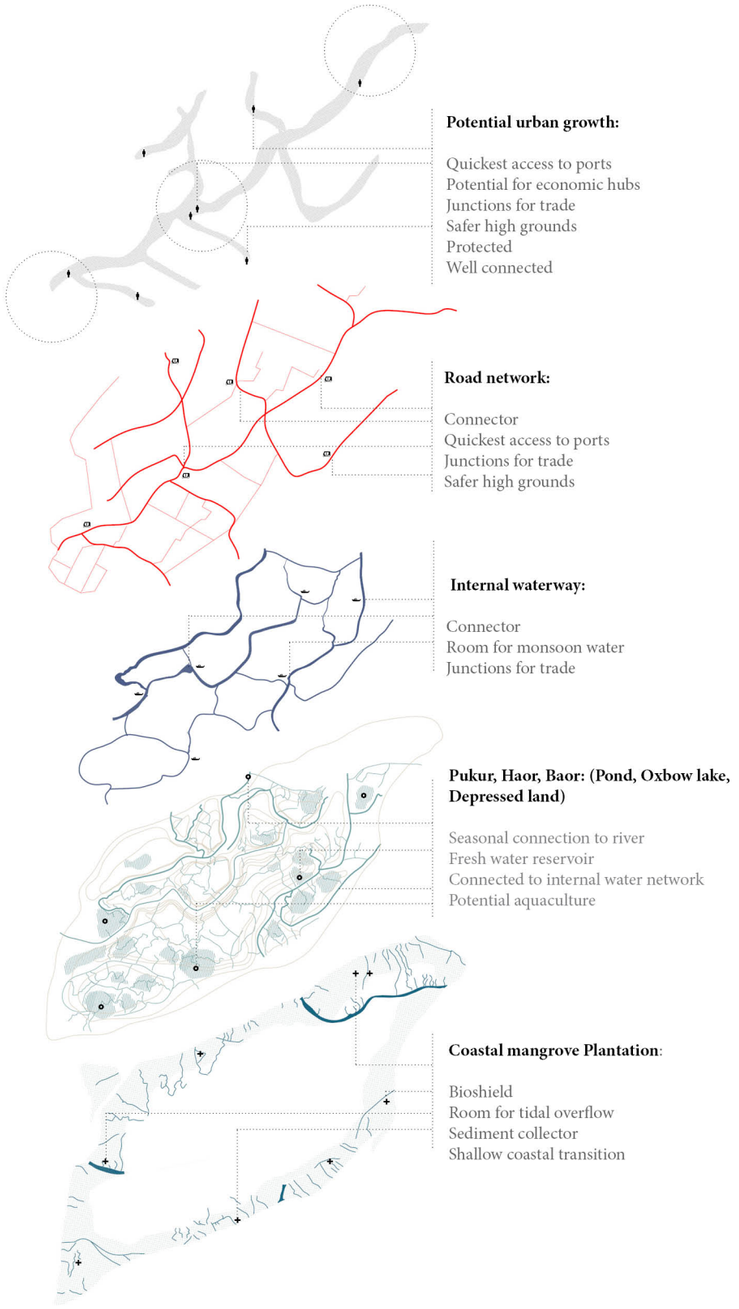
Urban areas | Road network | Waterways | Wetland | Forest

Potential Concentrated housing with productive forest
Coastal trail for Mangrove Plantation
Backbone of roads

Floating agriculture
Aquaponics
Ghaat and Bazars as part of economic corridor

Waterway as transportation
Rain water collection
Seasonal connection of internal and external water network
Seasonal wetlands





Potential urban growth:

Quickest access to ports
Potential for economic hubs
Junctions for trade
Safer high grounds
Protected
Well connected

Road network:

Connector
Quickest access to ports
Junctions for trade
Safer high grounds

Internal waterway:

Connector
Room for monsoon water
Junctions for trade

Pukur, Haor, Baor: (Pond, Oxbow lake, Depressed land)

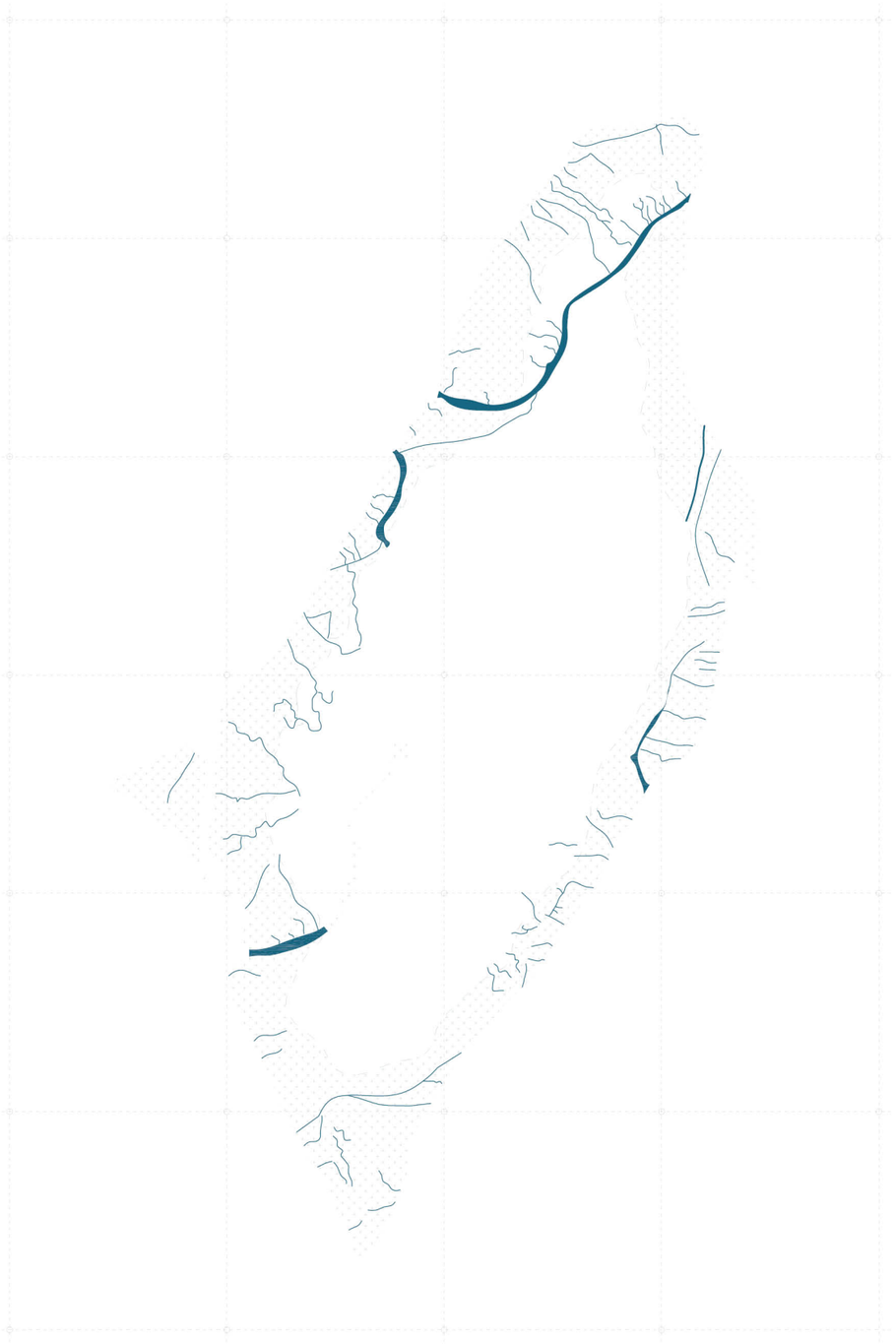
Seasonal connection to river
Fresh water reservoir
Connected to internal water network
Potential aquaculture

Coastal mangrove Plantation:

Bioshield
Room for tidal overflow
Sediment collector
Shallow coastal transition

Coastal mangrove Plantation:

The coastal mangroves will work as a room for tidal overflow as well as higher sea level. As a bioshield for the inhabitants, a tool for absorbing sediments and as a transitional low elevation coast for the island.
Can be phased by creating a trail along the existing polder and involve the community in the afforestation project.



Internal waterway:

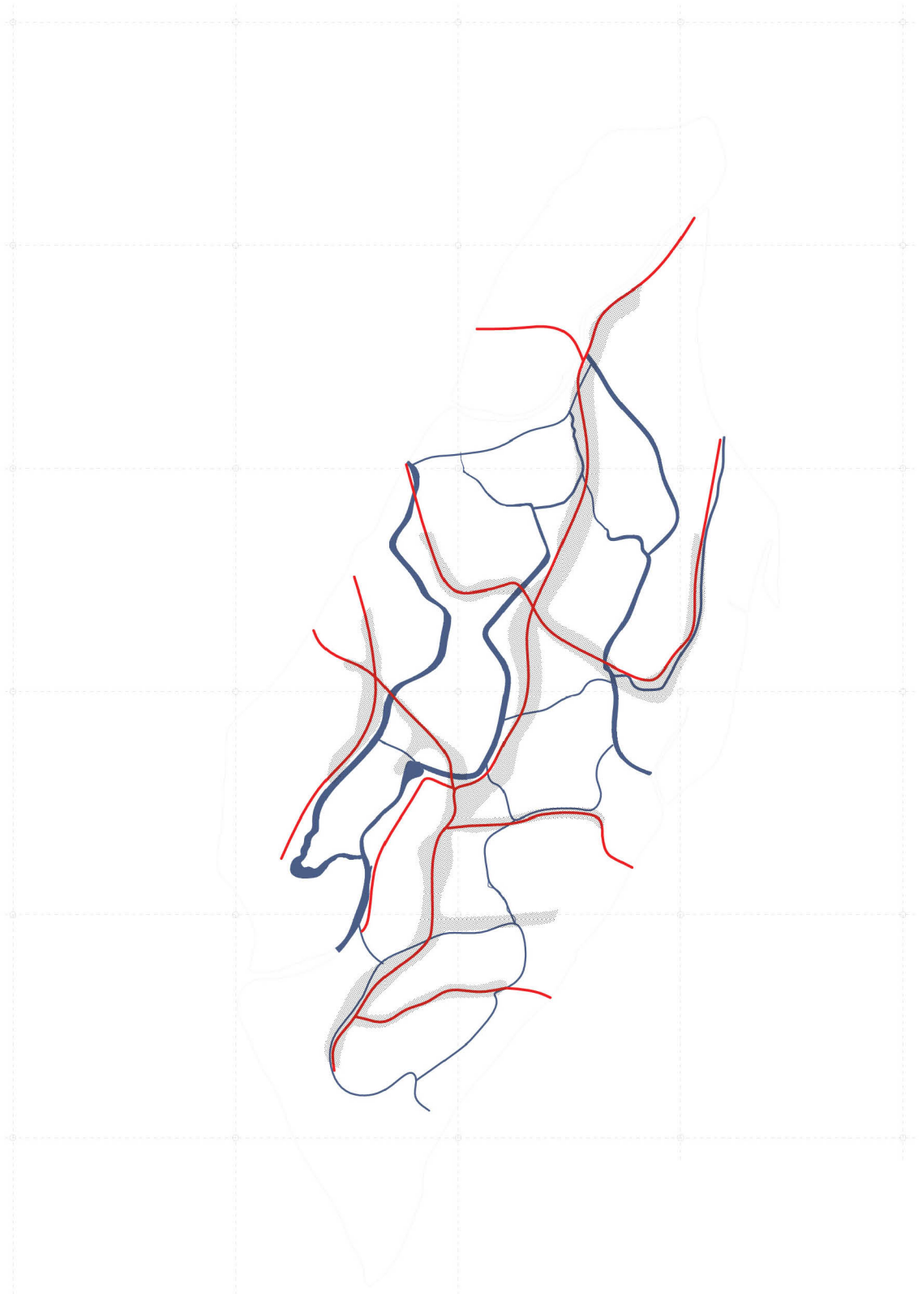
Some of the existing canals can be transformed into internal water-way for transportation within the island.

Road network:

By adding some connections there can be a well connected network of roads that can be the potential areas of new development.

Potential Inhabited lands:

The abandoned houses can be relocated to this new areas which are in higher lands and well connected to river transportation network.



Pukur, Haor, Baor:
(Ponds, Oxbow lakes, Depressed lands)

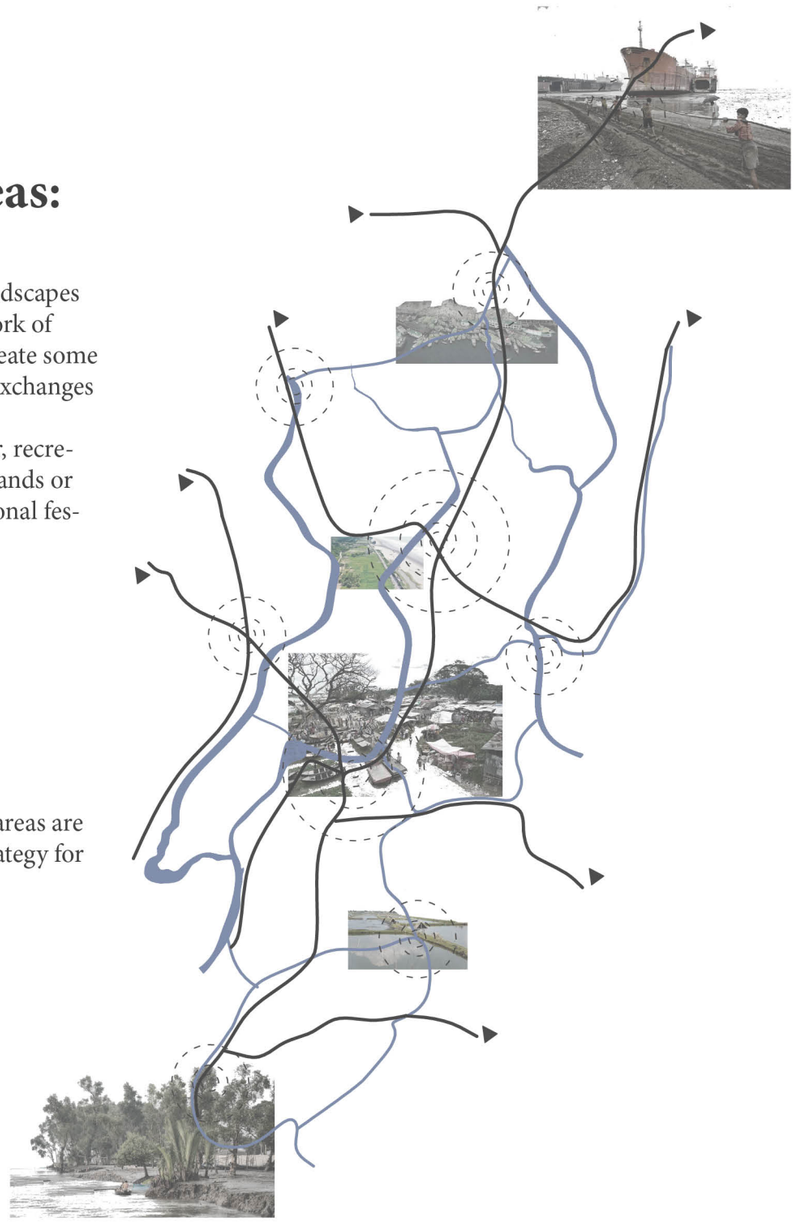
Connection of the internal water network with the external river network by creating gates in the polder. The gates can be opened seasonally, when there is more flow of fresh water from upstream .
Introduction of new pukurs (ponds), baors (depressed lands) and haor (oxbow lakes) for retention of rain water and generating aquacultures.

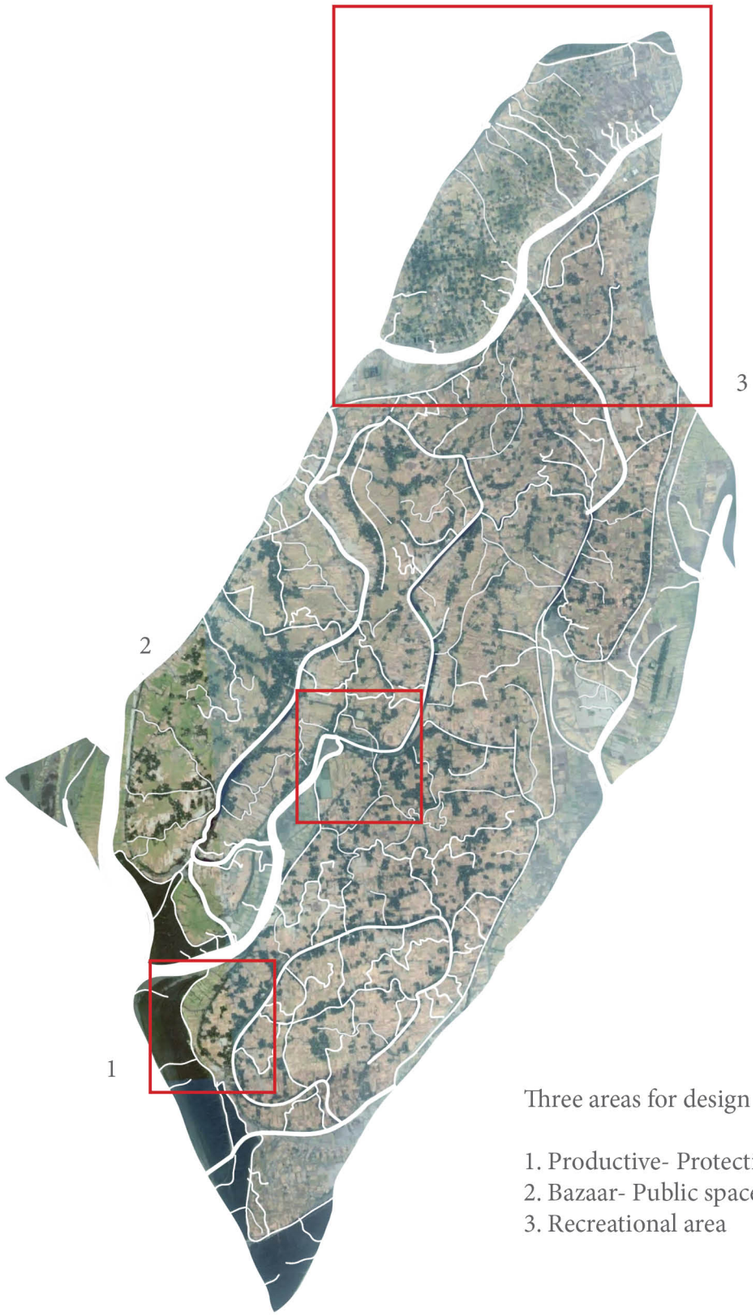
Design Areas:

The new diversified landscapes and connectivity network of water and roads will create some hotspots of economic exchanges and social interaction.
They can be port, bazar, recreational temporary wetlands or public squares for seasonal festivals.

Ghaat- Port
Bazaar- Market
Productive
Protective
Recreational

Three different design areas are chosen to apply the strategy for this island.



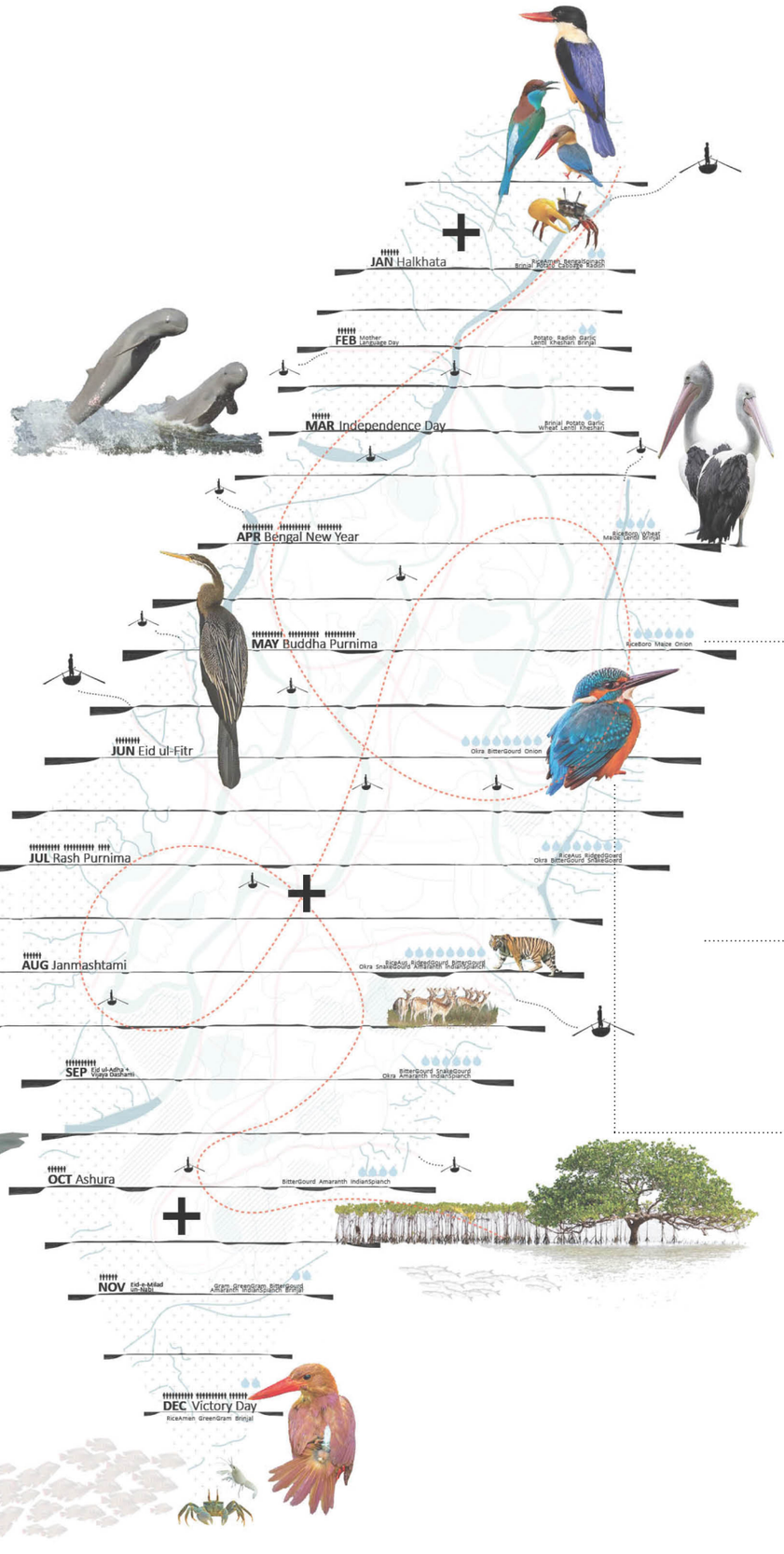


Three areas for design

1. Productive- Protective area
2. Bazaar- Public space
3. Recreational area

Toolbox for Design

The elements of this delta island are put together with seasons, festivals, rivers, boats, traditional techniques and seasonal productive species to prepare a toolbox for desiging the three selected areas.



Productive species

Crops

Rice aus
Rice amen
Rice boro
Wheat
Maize
Pulses
Gram
Lentil (masur)
Green gram (mung)
Kheshari

Floating agriculture

Kharif
Okra (lady's finger)
Ridged gourd (jhinga)
Bitter gourd (uchcheya)
Snake gourd (chichinga)
Amaranth (danta)
Indian spinach (puishak)
Robi
Bengal spinach (palongsak)
Brinjal
Potato
Cabbage
Radish
Onion
Garlic

Aquaculture
Rui
Catla
Mrigal
Silver carp
Common carp
Mirror carp
Grass carp
Shrimp

Birds species:

Rudy Kingfisher
Black capped kingfisher
Stork billed kingfisher
Collard kingfisher
Blue eared kingfisher
Pelicans
Oriental Darter
Kite Haliester
White bellied Fish Eagle
White breasted Woodswallow
++

Mammals:
Deer
Royal Bengal Tiger
++

Amphibians:
Crocodile
Lizard
Frog
Snake
++

Forest:

Intertidal Forest
(Coastal Marsh and Mangroves)

Bruguiera cylindrica (20m)
Acanthus ebracteatus (1.5m)
Avicennia lanata (30m)
Achrosticum aureum (1.8m)
Bruguiera sexangula (15m)
Ceriops decandra (35m)
Rhizophora mucronata (15m)
Rhizophora stylosa (5m)
Xylocarpus moluccensis
++

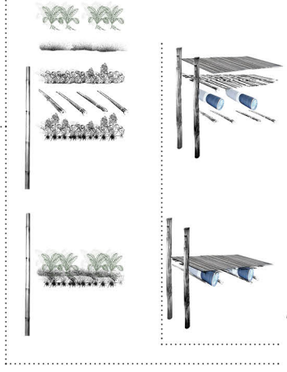
Brackish water Forest:

Bruguiera gymnorrhiza
Bruguiera parvifl ora
Bruguiera sexangula
Acanthus illicifolius
Achrosticum aureum
Aegiceras corniculatum
Aegiceras floridum
Avicennia alba
++

Productive Forest:

Cocos nucifera
Mangifera indica (Mango tree)
Garcinia mangostana (Mangosteen)
Hibiscus tiliaceus
Coccoloba uvifera (Sea Grape)
Kapok tree
Azadirachta indica (Neem tree)
Green grapefruit tree
Musa paradisiaca (Banana tree)
Hylocereus (Dragonfruit)
Kleinhovia hospita (Guest tree)
(Mangrove trumpet tree)
Cinnamomum cassium
Durio zibethinus (Durian Tree)
Sugar Palm
++

Forest succession:
Sonneratia apetalo (Keora)
Nypa fruticans (Golpata)
Conocarpus erectus (Baen)
Exocoecaria agallacha L. (Gewa)
Heritiera fomes (Sundari)



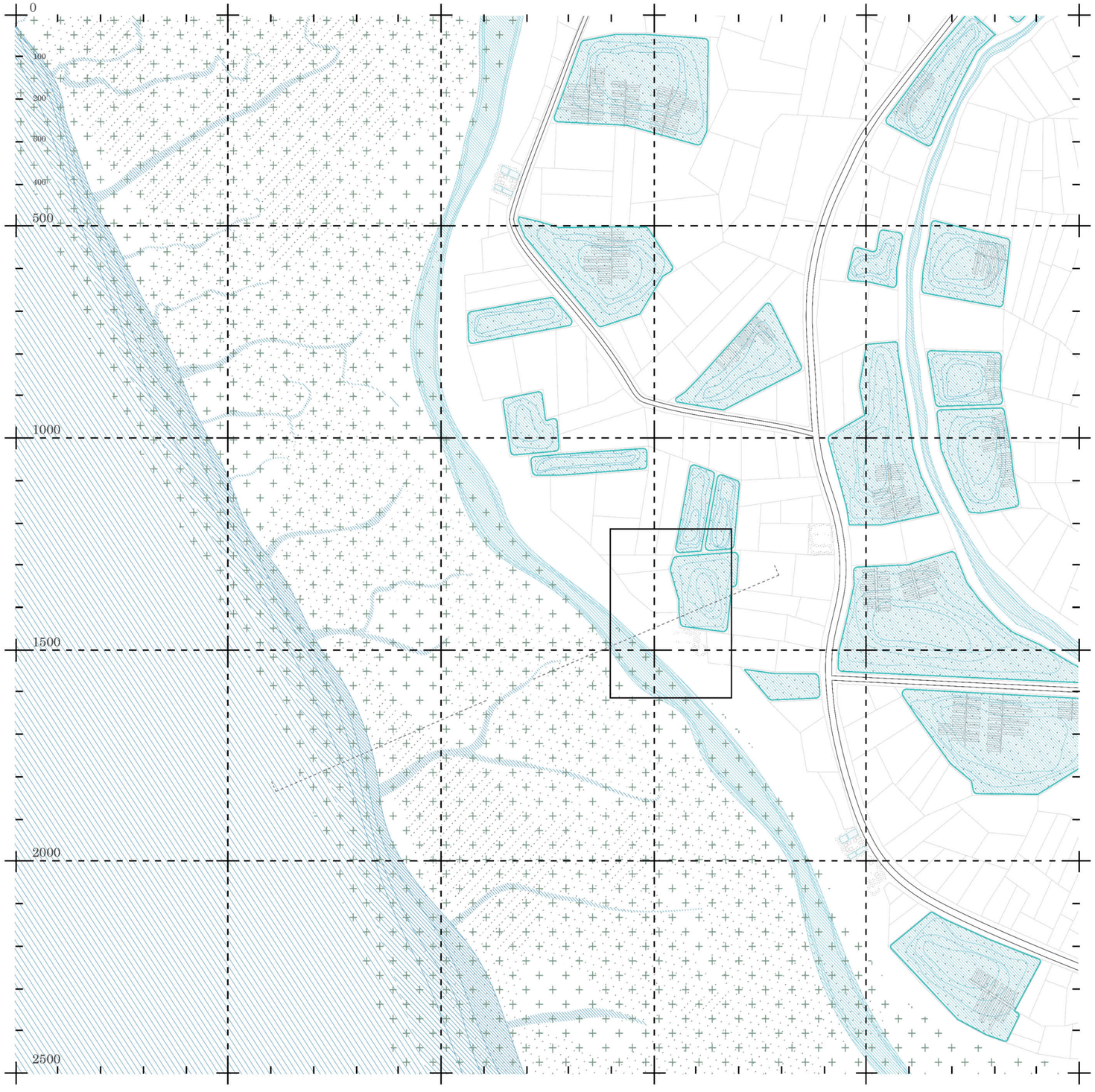
Traditional techniques:
Floating Decks (Macha)
Floating agriculture (Baira)

Protective and Productive

With the sea level change and more rainfall and flooding, the agricultural fields are proposed to be transformed into diverse traditional activities. Applying cut and fill method, along with the floating concept of agriculture the local communities can continue to cultivate crops and vegetable. Aquaculture with the floating crops work in the hydroponics concept. Some of the fields can be used for different crop species in different seasons with varying water levels.

The coastal forestation strategy creates a buffer between the saline water and the internal freshwater. This will allow the productive fields to continue for longer period. The roots of mangroves absorb the sediments, thus allowing the land to raise. This protective landscape saves the fields and the habitats from cyclones and allows the tidal surge to transit.

The mangrove forests have a diverse ecosystem and it attracts many species like crabs, shrimps and honey bees and they can become part of the productive landscapes.

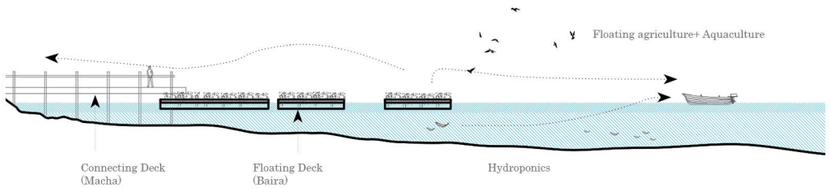


Situation Map: Productive and Protective

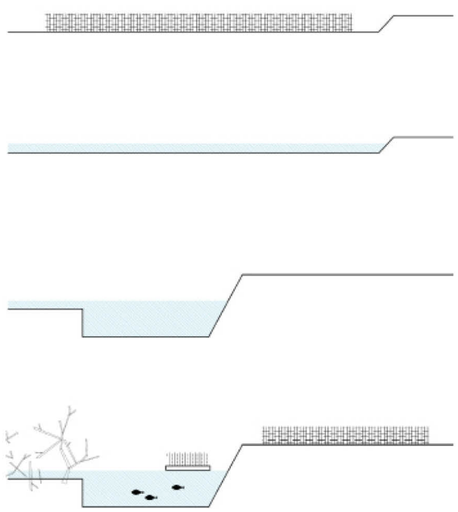
Sea
Forest
Fresh water
Aquaculture
Agriculture

Plan: Productive and Protective

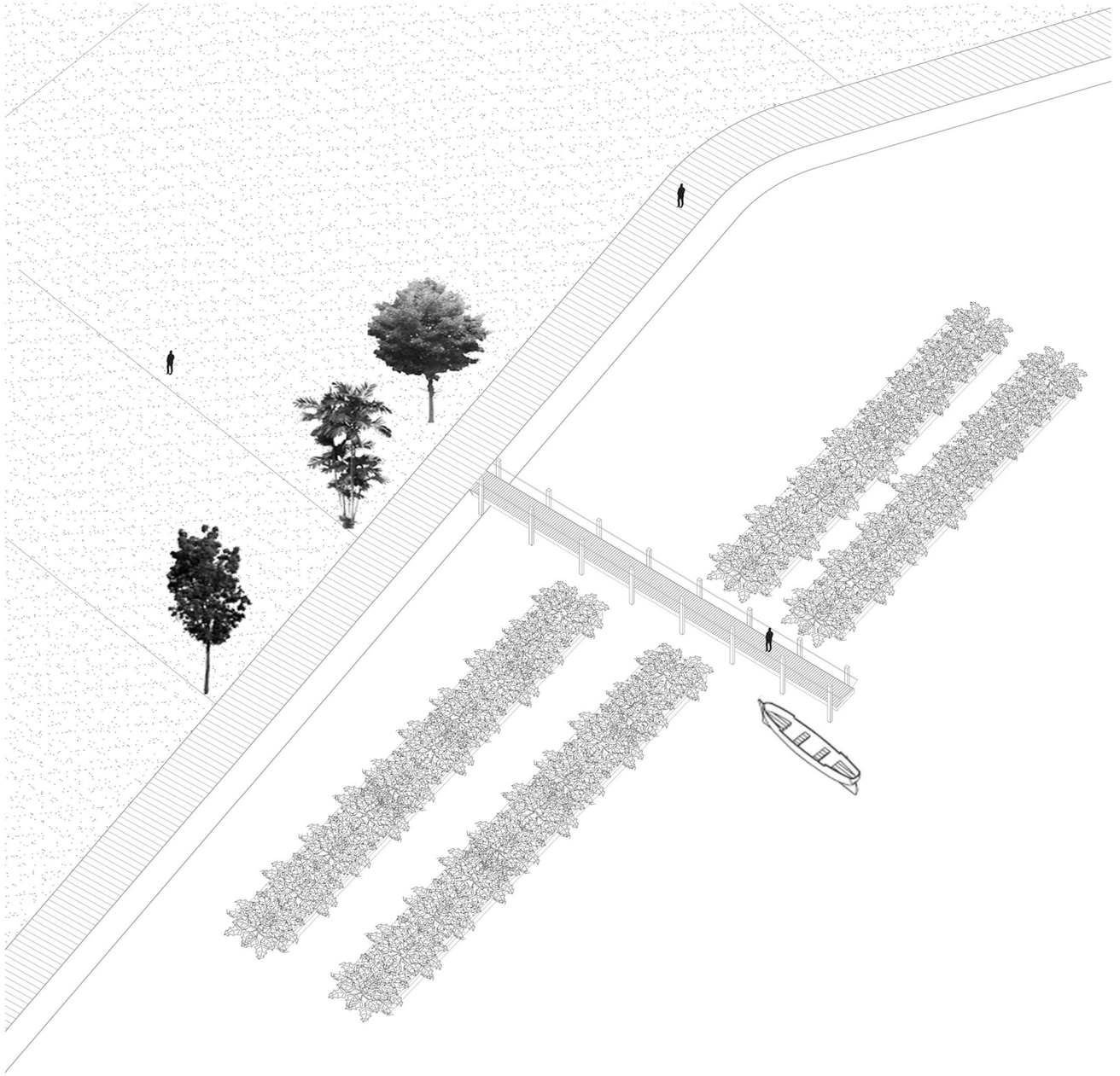
Section: Protective and Productive



Section: Protective and Productive



Sea level change + more flooding + traditional hydroponics
Diverse Productive landscapes



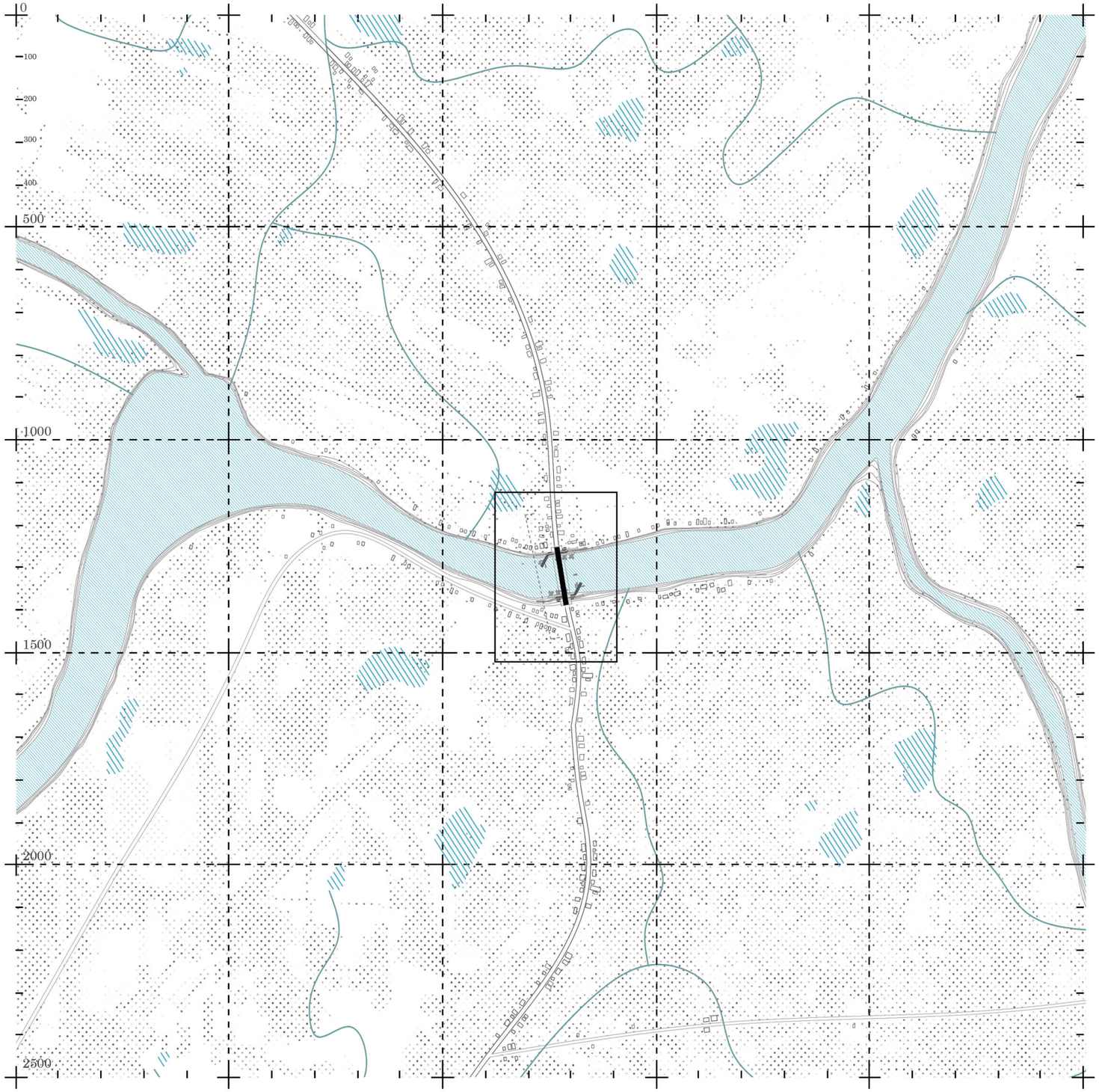
Axonometric: Floating agriculture

Water and Urbanism

As part of the waterway strategy, the bazaar road that blocks the flow, has been replaced with a bridge opening up a navigable water stream.
The proposed bridge is constructed with steel that is recycled from the ship breaking, an existing local industry in nearby mainland.
The bazaar is then placed within the bridge.

The new connections along the waterway creates new movements and interactions. The edges become new places of trade.
Hence the port becomes the bazaar.

The intersection of these various directions and diverse activities create new thin cities.



Situation Map: Bazaar and Port

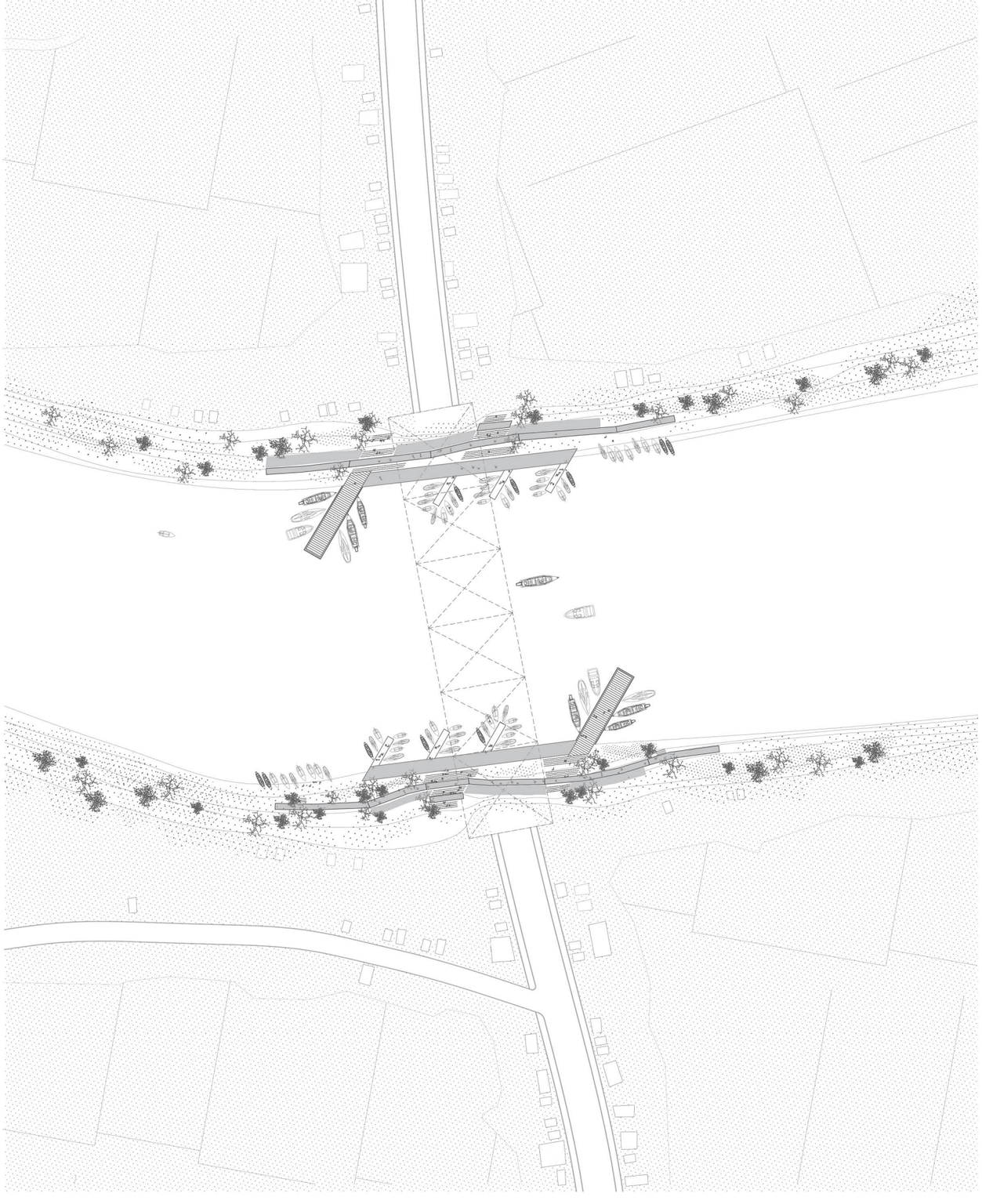
Scale- 1:10000

Waterway

Urban area

Productive fields

Reservoirs\ Seasonal wetlands



Plan: Bazaar and Port

Scale- 1:1000

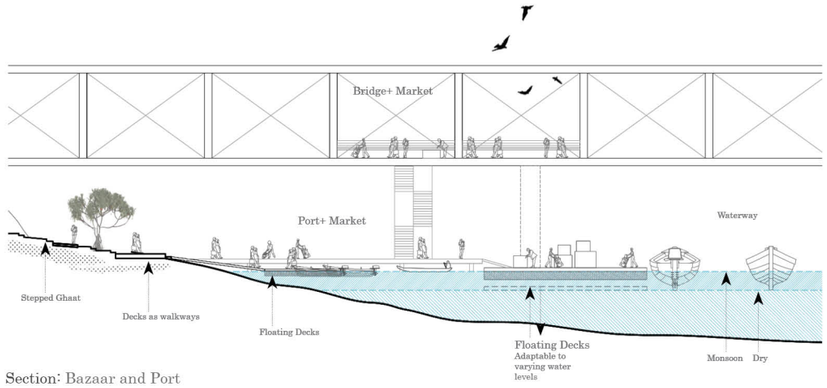
Waterway

Agriculture

Seasonal wetland

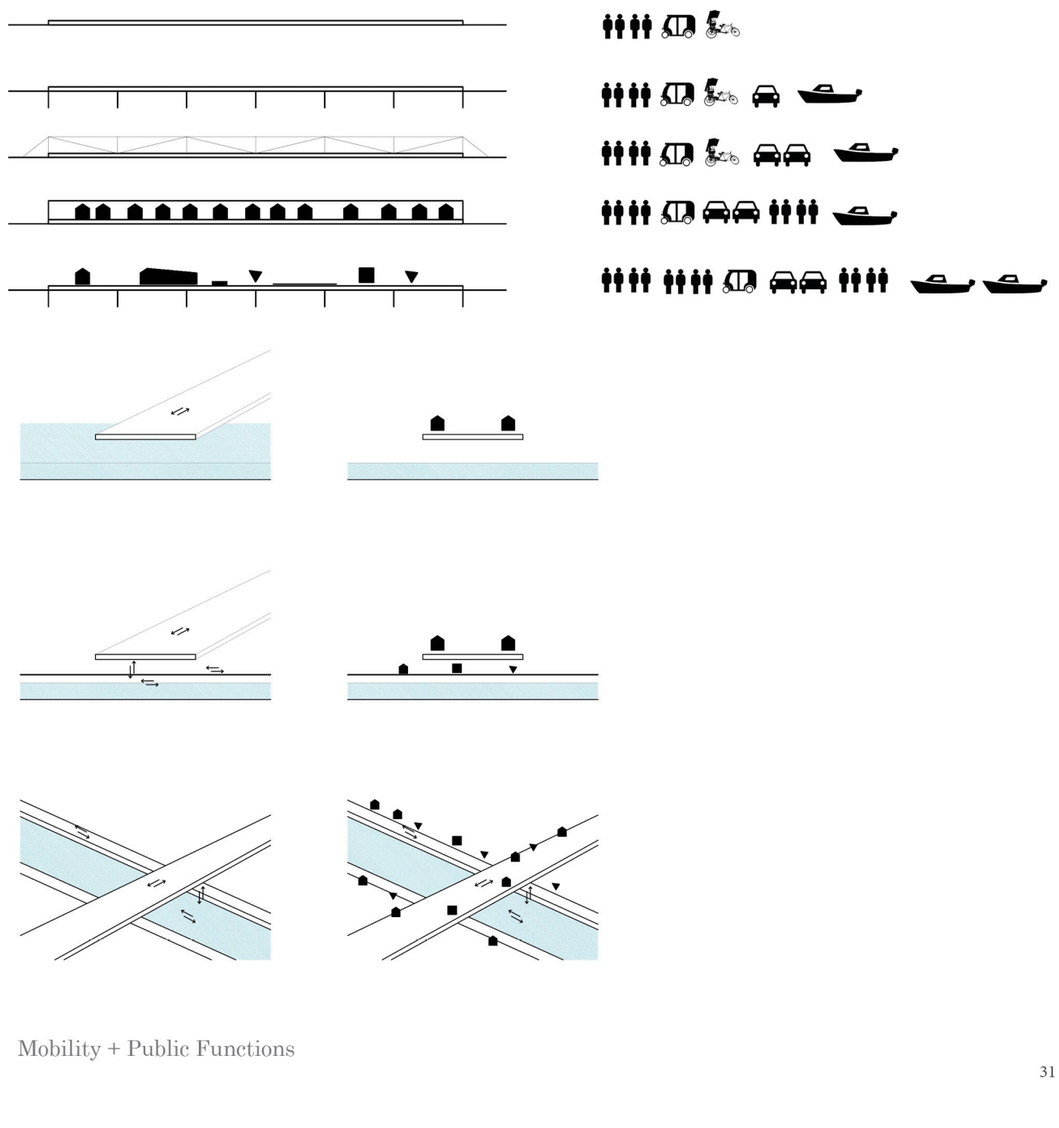
Road

Pathway

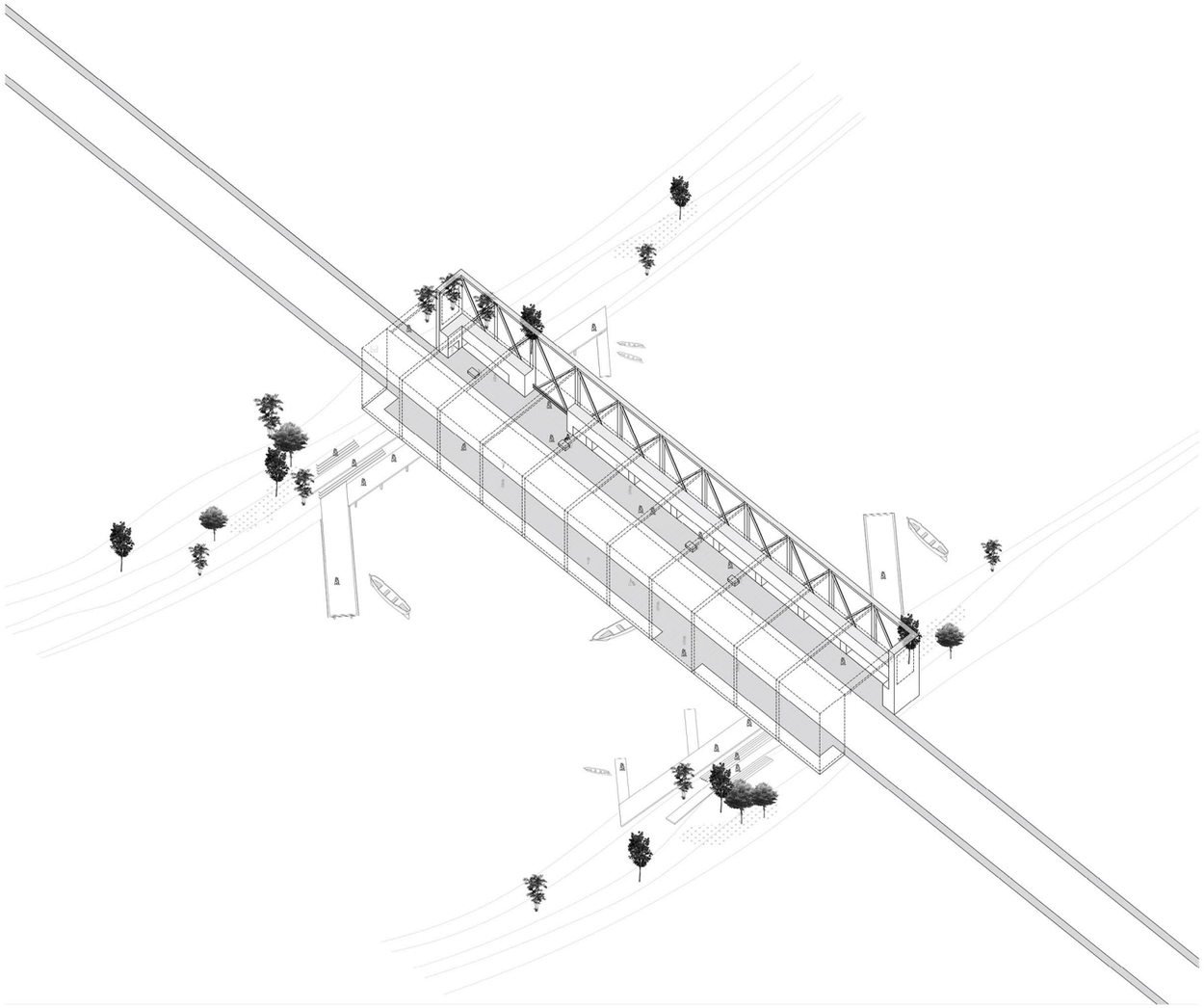


Section: Bazaar and Port

Scale- 1:250



Mobility + Public Functions



Axonometric: Bridge+ Bazaar

Recreation and Restoration

When the new islands are emerged through sedimentation, they become mangrove forests very fast through government initiatives. With the people settling in the islands, these forests are replaced by agricultural activities.

The proposed coastal forest strategy can be applied to some smaller islands by restoring lands to create forest parks and reserves.

As part of the MFF project (Mangroves for Future), the local communities can be involved in reforestation projects and create a forest park.

The mangrove forest park will include a trail through a designed route with light structured and open bird watch towers along the way. The entry is through waterway and it includes port for houseboat parking.

This trail is designed by using the traditional methods and local materials. It is elevated and the visitors can explore the changes in landscapes by walking along the wet and dry, muddy and sandy, high dense forest and low barren fields: an experience of the wet terrain.

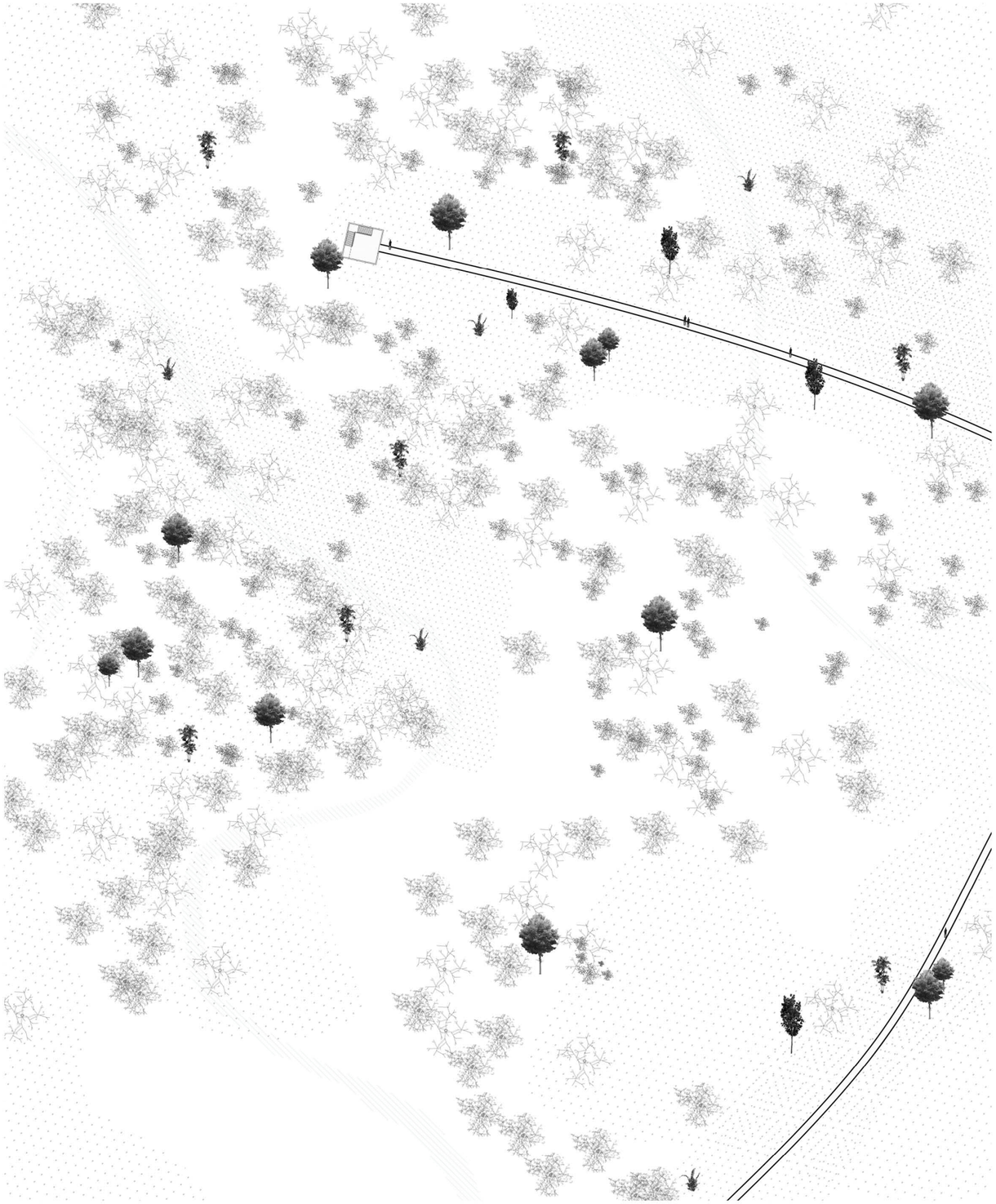
Situation Map: Recreation and Restoration

Sea

Mangrove forest

Productive fields

Forest trail



Plan: Recreation and Restoration

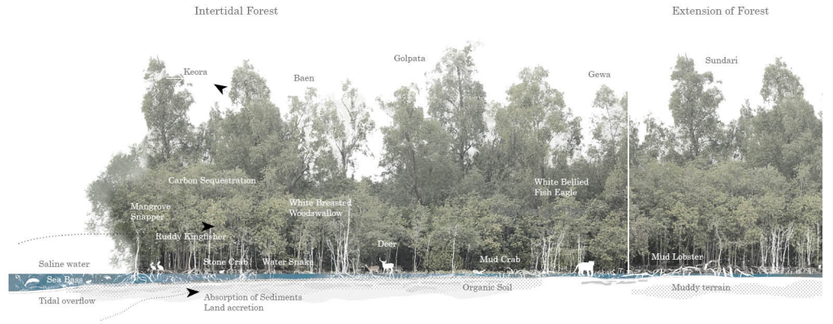
Scale- 1:1000

Mangrove Forest

Elevated trail

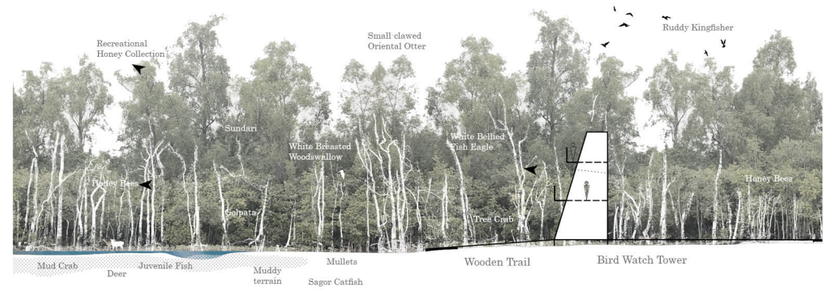
Muddy terrain

Bird watch



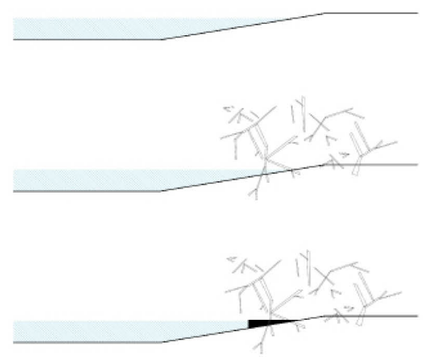
Section: Ecosystem

Scale- 1:250

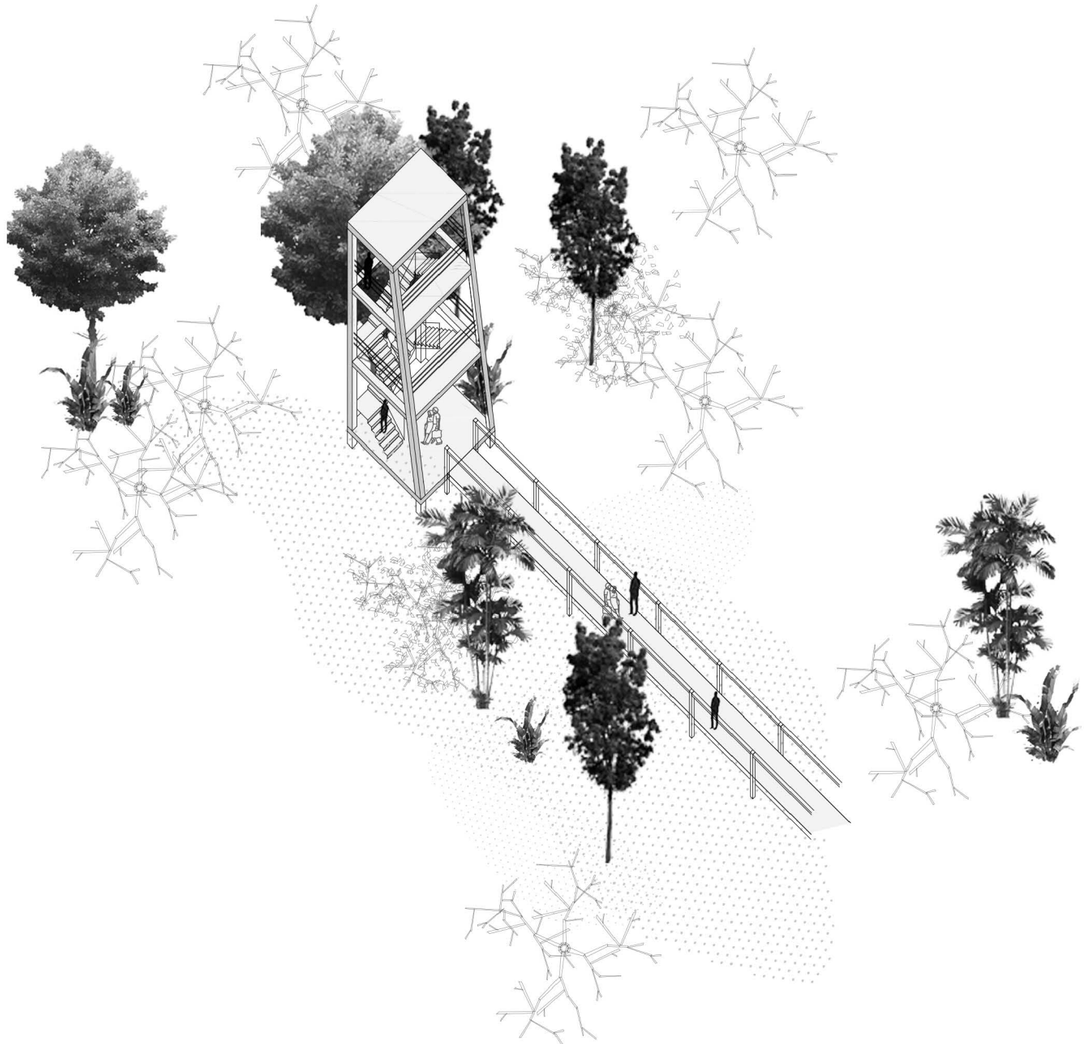


Section: Recreational activities

Scale- 1:250



Mangrove plantation+ Sediments
Land surface accretion



Axonometric: Bird watch tower

The Future Wet Terrain

The main objective of this thesis is to explore the possibility of sustaining the landscapes and its inhabitants in an adaptable way in the context of climate change. By embracing the gifts of this wet terrain and adapting to its changes, the communities can continue to live in these shifting landscapes. The toolbox for design is an indicator of the rich biodiversity and the resources it contains within this delta. By adopting some of the landscape strategies, the existing cities can be transformed into evolving and adaptive cities where people can continue to live in 2100.

The three areas of design can be considered as testing grounds which can be later applied to different areas and islands. The smaller islands being restored into mangrove forests can create a chain of bioshields that will further protect the inlands. The densified higher lands with living areas and the diverse productive landscapes can create thin cities within high yielding fields. Waterways can become the main modes of transportation and the connectivity of the islands through rivers and ports can create an economic corridor, boosting the exchange and interaction.

Where water has been the constructor of landscapes and nurturer of life, designing strategies with the shifting nature of water and land can be an answer for the future when there is more water in this delta.

Perspective: Protective and Productive

Perspective: Bridge+ Bazaar

Perspective: Forest park

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